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ABSTRACT

Communication behaviors which facilitate cooperative problem solving were investigated in 3- to 5-year-old children. Thirty-two dyads, matched on age, sex and friendship were videotaped as they used balance scales to locate pairs of blocks of varying weight and surface design, but identical in size. All subjects had conventional labels for the designs. The results indicated that the effectiveness of these preschool children in cooperative problem solving coalesced from three to five and this effectiveness was predicted not by the praise that was given or received, nor always by the precision of their language from an adult perspective. Rather, the effective dyad was one who attended to the task and could establish and reestablish focus, who was mutually responsive, and who could use some system of distinctive labels. The study provides support for a developmental sequence of communication skills for dyadic problem solving; linking its findings to questions involving tutoring and persuasion are important next steps in helping children learn from one another. (MS)

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Collaboration in Children: Dyadic Interaction Skills in Problem Solving[1]

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In a preschool classroom children talk with one other all day and we assume that they are learning together. But how do children help each other learn? By what skills can the most effective collaborators be identified?

This paper reports a study examining the specific communication behaviors which facilitate problem solving in young children. Currently some investigators focus on the development of communication it its own right (Garvey, 1976), while others have observed the peer group as a setting of special effectiveness for cognitive growth (Hartup, 1977). The present study represents a synthesis of these two concerns by focusing on a situation in which specific communication behaviors were evaluated for their role in facilitating cognitive gain.

The ability under investigation can be placed in a developmental framework of dyadic communication skills of increasing difficulty for the young child. At the first level can be placed the ability to participate in reciprocal interaction. Mueller (1972, 1977) has reported that in natural play situations with familiar objects and with the listener in view, preschool children are already able to produce clear, audible, and complete utterances that function successfully to maintain interaction and elicit replies from listeners.

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On the other hand, preschool children have more difficulty in tasks of referential communication in which two children are separated by an opaque barrier and are asked to describe unfamiliar stimuli. In the task of Glucksberg, Krauss, and Weisberg (1966), which is illustrated in the upper half of Figure 1, young children had difficulty both in the role of what Garvey (1971) has called the knower, who has the information necessary to solve the problem and must communicate it effectively, and in the role of the doer, who lacks information and must obtain it from the knower.

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[1] Presented at the biennial meeting of the Society for Research in Child Development, New Orleans, March, 1977.

The present study was designed to investigate children's effectiveness as collaborators in problem solving, that is, in a doer-doer situation in which neither child has the information sufficient to solve the problem. This mutual coordination by two children towards the achievement of a common goal is seen as requiring more complex skills than simply obtaining replies from another person, but less complex skills than the the referential communication tasks involving tutoring (Allen, 1976) or persuading another person to change his viewpoint, as has been investigated in conservation training studies (Miller & Brownell, 1975).

In the present study, 32 pairs of preschool children, matched for age and sex, participated at their preschool and day care centers. The children ranged in age from three to five years with an equal number of boys and girls divided between younger and older groups. The dyads were composed of friendship pairs in order to encourage the most advanced level of verbal interchange. The pairs were videotaped as they jointly solved the task illustrated in the lower half of Figure 1: the dyads sat side by side in front of a pan balance scale to locate six pairs of matching blocks, which varied in weight and surface design but not in size.

The designs were simple line drawings of a man, house, and flower. In each child's set, there were six blocks, with six different weights, and three designs. Thus, two pairs of blocks in each child's set of six had the same design, so children could not solve the problem simply by matching pictures. When ordered by increasing weight, blocks with the same face design were never contiguous in the series.

As the children placed a pair of blocks of matching weights in the pans of the scale, a rod attached to the center of the crossbar pointed down to a clown's face attached to the base of the scale. In this way, the children were capable of confirming a successful match by themselves, and even children who did not understand the principle of balance scales could be given an explicit criterion for a successful match. With four pairs of solid colored blocks, the experimenter demonstrated

how some blocks made the rod point to the clown and these were to be placed in boxes adjacent to each child's pan. Those that did not were to be placed back in the child's pile of blocks. Giving each child his set of experimental blocks, the experimenter encouraged the children to find all the blocks that made the rod point to the clown. The children were allowed to play as long as they wanted. If they had been unsuccessful in locating any matching pairs, at the end of the session the experimenter rejoined them and unobtrusively suggested blocks to place on the pans so that all children experienced success on the task.

The videotapes were first coded for four dependent variables which measured performance on the task; a) the number of successfully matched pairs of blocks, six being the maximum; b) the total number of pairs placed on the scales (the number of attempts); c) the ratio of matched pairs to total attempts, which provided an indication of the efficiency, of the dyad's search for solution; and d) the time utilized by the children in doing the task.

Our first analysis focused on the performance on these four dependent variables by age and sex; Table I shows these data. Older children exceeded younger children in the total number of successful matches and in their efficiency (the ratio of successes to attempts). There were no significant age differences in the total number of attempts, nor in the time the children played with the materials, although older girls took less time and older boys more. (The boys seemed more involved with the materials but less involved with the task as defined by the experimenter.) Children who were successful were also efficient, but these children did not take less time playing with the materials than did the less successful children.

The second portion of the data analysis focused on identifying what communication behaviors predicted the two key dependent vaiables of success and efficiency. The videotapes were scored for communication behaviors which fell into five categories: a) attention-focusing statements, such as "hey", "look", or saying the

other child's name; b) task-relevant questions, directives, comments, and irrelevant comments; c) evaluative feedback, either praise or criticism; d) acknowledgment or lack of response to the partner; and finally the accuracy with which the child described the designs and weight of the blocks. Reliability of coding for each category was established and monitored.

Success and efficiency were predicted by two different patterns of communication behavior. As illustrated in Table 2, success was predicted by the use of accurate labels, the use of comparatives, such as "heavier", and the relative absence of irrelevant comments. In contrast, efficiency was predicted by the absence of irrelevant comments and by the use of the terms "big" and "little", even though the blocks were in fact the same size.

After looking at the predictors of overall effectiveness, we then moved to examine what influenced the success or failure of each attempt the dyad would make. The stream of interaction was segmented by considering each time the children placed a pair of blocks on the scale as a trial. The contingency between communication behavior and success could thus be examined for each trial. For example, the presence or absence of attention-focusing statements was tabulated for successful and unsuccessful trials to see if their use was associated in a distinctive pattern with efficiency on the task. As shown in Table 3, Chi-square analysis revealed that for older children, success on an individual trial was predicted by the presence of attention-focusing statements, questions, directives, accurate labels, the use of attributes- inaccurate by adult standards of "big" and "little", and accurate nonverbal responding, as well as by the absence of ignoring the requests of the partner. For younger children, the absence of irrelevant comments predicted success on individual trials. Praise occured on only four pairs of children.

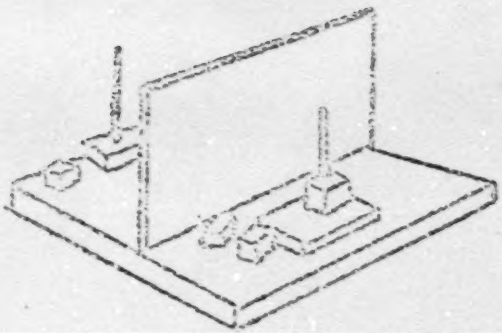
A flavor of these differences in effectiveness can be given by citing the examples of two different pairs of children who worked together, trying to match blocks.

One child asked her partner, "Which one should I try?" "Oh, try any one..." was the answer. The first child then made another in a series of unsuccessful attempts. In a second pair, a child looked among her blocks, which were all the same size, but different weights, and said to her partner, "Try the little one," picking up a light hollow block and shaking it. "You mean this one?" asked her partner, shaking a similarly empty block. "Yes," said her friend. They put their blocks on the scales and found a match.

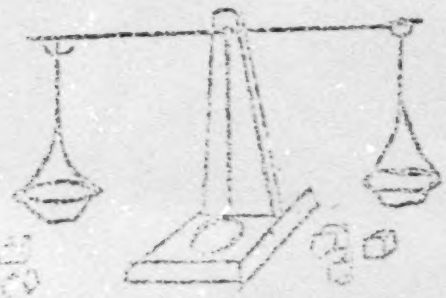
This study indicated that the effectiveness of these preschool children in cooperative problem solving coalesced from three to five, and this effectiveness was predicted not by the praise that was given or received, nor always by the precision of their language from an adult perspective. Rather, the effective dyad was one who attended to the task and could establish and reestablish focus, who was mutually responsive, and who could use some system of distinctive labels. The study provides support for a developmental sequence of communication skills for dyadic problem solving; linking its findings to questions involving tutoring and persuasion are important next steps in helping children learn from one another.

Figure 1

Comparison of Two Dyadic Interaction Tasks



Referential Communication Task
(Glucksberg, Krauss, & Weisberg, 1966)



Dyadic Problem-Solving Task
(Cooper, 1977)

Table 1

Performance on Dependent Variables

Variable	Mean Score: Young Girls	Young Boys	Old Girl	Old Boys	Significant F Ratios
Matches	1.88	2.00	4.62	3.50	Age: $F(1,28) = 8.38$, $p < .01$
Matches per trial	.19	.14	.48	.32	Age: $F(1,28) = 8.16$, $p < .01$
Total trials	31.25	24.38	18.50	9.50	
Time (sec.)	314.00	125.00	244.00	282.00	Age x Sex: $F(1,28) = 4.23$, $p < .05$

Table 2

Prediction of Matches and Matches Per Trial

by Communication Behaviors

Matches			Matches Per Trial		
Predictor	Multiple R	Overall F	Predictor	Multiple R	Overall F
Accurate Labels	.45	7.76**	Irrelevant Comments	.35	4.30*
Comparatives	.52	5.37**	"Inaccurate" attributes	.46	4.00*
Irrelevant Comments	.60	5.29**			

*$p < .05$

**$p \leq .01$

Table 3

Prediction of Matches (Chi-Quare[1]) on Individual Trials by Presence or Absence (AB) of Communication Behaviors for Younger and Older Dyads

Behavior	Young	Old
Attention-focusing	1.56	4.37*
Relevant question	.69	5.33*
Directive	.33	4.61*
Relevant comment	3.08	3.47
Irrelevant comment	4.07*(AB)	2.74
Ignore	2.28	5.46*(AB)
Accurate Label	1.08	11.53**
"Inaccurate" attribute (big or little)	0	4.69*
Comparative	10.47**	.72[2]
Informative verbal response	.37	5.72*
Accurate nonverbal response	.01	16.65***

[1] $df = 1$

*$p < .05$

**$p < .01$

***$p < .001$